Playful interactions with smart and social objects

supporting intergenerational engagement in learning about Cultural Heritage of rural territories

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Abstract — **LOCUS proposes de co-design, development and evaluation of an IoT system that incorporates and interconnects smart and social objects, supporting tangible and playful interactive experiences, intended to promote intergenerational engagement in creating and exploring cultural contents and learning about cultural heritage of rural territories from the Centre Region of Portugal, namely Amiais Village, in Sever do Vouga.**

Keywords - Intergenerational; Internet of Things; Smart Things; Social Things; Playful; Rural Territories; Cultural Heritage.

I. INTRODUCTION

Information and Communication Technologies (ICT) has been playing a key role in addressing societal challenges. Internet of Things (IoT), in particular, is currently one of the most impactful ICT solutions, which has been acting as a powerful innovation driver, coming to revolutionize people and enterprises' routines [1,2,3,4,5].

IoT refers to a global infrastructure, which interconnects virtual and physical everyday things. By using data capture and sharing features and interoperable processing and communication protocols, these things, or objects, become smart, as they show intelligent behavior in connection and interaction with other devices [6,7,8].

Also, smart objects operate interactively and autonomously over the internet [6], being capable of providing information and services (even new ones) to users, without direct human intervention [7,8,9]. Augmented by technology, objects gain the ability to sense, process and communicate on the network, being able to interact with human users and other objects and to trigger actions on the physical realm [1,2,7,10].

IoT genesis is clearly utilitarian and its applications are diversified. Within the human scope, IoT has been mainly used for health/wellness support and work productivity enhancement [11,12].

In addition to the considerable technical challenges raised by IoT, in which research has been predominantly focused, there is also a growing interest on how people can connect and interact through IoT, in a socio-cultural and playful perspective, and what impact it has on our lives [13,14].

Reference [15] suggests that objects' smartness depends on how people are able to interact with them, emphasizing that the key challenge for making smart objects successful is to design usable and useful interactions with them. Such approaches find arguments in the theories of socio-material relations, which demonstrate the constitutive entanglement of social and material in everyday life [16] and Actor-Network Theory (ANT) [17].

According to [18], the kind of associative focus on the social stressed by ANT is particularly interesting to identify spatialisation in communication processes, as well as in processes emerging through current geolocation technology and media, like IoT. In fact, the idea that objects have social properties have been inspiring some technical and communication solutions for (a Social) IoT [19,20,21].

LOCUS addresses the need to reduce social isolation and promote rural territories, while avoiding the waste of older adults' experience and knowledge and preserving the cultural heritage of those territories through ICT, being particularly interested in how playful interactions with smart and social objects can be designed to support intergenerational communication.

By allowing the augmentation of everyday objects and routines [22], IoT seems an adequate solution to digitally connect older adults, who are often the most reluctant to use ICT [23,24,25].

As such, LOCUS] proposes de co-design, development and evaluation of an IoT system that incorporates and interconnects smart and social objects, supporting tangible and playful interactive experiences, intended to promote intergenerational engagement in creating and exploring cultural contents and learning about cultural heritage of Amiais village.

Amiais is a very small and rural village in Sever do Vouga (Aveiro district, Portugal), with an ageing population and ancient rural traditions, which are still practiced by the few permanent inhabitants.

The project implements a playful and immersive cultural heritage tourism approach, in which Amiais' visitors will have gamified experiences, by using a wearable device (bracelet) and their smartphones to interact with augmented everyday things around the village and to collaboratively learn about Amiais' culture and produce and share multimedia georeferenced contents.

II. BACKGROUND

Considering its pervasiveness, IoT is the perfect context for digitally enabling playful learning experiences and non-structured free play activities in everyday spaces [26,27]. In the last years, several projects explored these domains, with different and interesting approaches. Naming just a few:

- Ghost Hunter is an IoT interactive system that, by evoking the hide-and-seek game, intends to help families identify and reduce household energy consumption. For such, the system engages parents and children in gamified activities for finding out hidden sources of energy consumption in their homes [28];
- Messaging Kettle aims to foster healthy ageing, supporting social connection and communication with a distant elderly friend or relative, by augmenting the routine of boiling the kettle to make tea [22];
- The Storytellers Project is a library remote reading aloud service, that connects older adult readers to children and their families. Older adults borrow children books and get an augmented bookmarker, while Children and their families borrows an augmented storyteller doll. By playing with the doll, the child requests a storytelling to the community of storytellers, which will be notified through their bookmarker, with a sound and light. The bookmarker will also capture and transmit the readers voice, that will be listen through the doll [29].

On the other hand, protecting our tangible and intangible cultural heritage and fostering creativity is crucial to social identity and cohesion and to build inclusive and pluralistic societies [30,31].

Cultural heritage meanings and values emerge from the chains of connectivity linking humans, artifacts, places and practices [32], as stated by ANT. IoT can bring those connections to matter, in formal and informal cultural heritage settings:

- Moving People spread 3D refugees' miniatures around Amsterdam public spaces, linking to their on-line stories [33];
- Tales of a Changing Nation augmented objects from Scotland's history with digital information and also let people attach personal memories do them [34];
- The meSch project provides a IoT platform for heritage professionals to enrich exhibitions' objects with digital content, through augmented reality [35].

Also, the promotion of social inclusion and economic development in rural areas, namely through ICT, is one of the 6 priorities to be addressed by rural development programmes of European member states and regions, which is reflected in the Portuguese national and regional priority domains of specialization, namely those with which this project is aligned with [36,37]. Yet, R&D on the role and impacts of IoT in the preserving and promoting cultural heritage, namely of rural territories, is globally reduced and national projects are unknown.

LOCUS contributes to fill this gap, as it implements a playful and immersive cultural heritage tourism approach to foster cultural and socioeconomic development of Amiais Village and promote intergenerational communication, as a mean to avoid isolation and contribute to healthy ageing. The project will deliver an IoT system, which will enable immersive gamified experiences, through which visitors can collaboratively learn about cultural heritage and produce and share multimedia georeferenced contents.

III. METHODS

LOCUS has the following specific objectives:

a) Engage inhabitants and stakeholders in the IoT system co-design, development and evaluation process;

b) Assemble and test a strategy to integrate Participatory Design and Agile Development methodologies;

c) Understand how smart objects and IoT systems and applications should be designed to promote playful and intergenerational interactions and experiences, in the context of which rural cultural heritage can be learned and shared;

d) Understand how individual characteristics (age, background, culture, digital literacy, goals, roles, etc.) may impact the way people interact in/with a playful and intergenerational IoT system and how they cooperate in creating and exploring cultural contents;

e) Develop an insight on how the physical and technological characteristics of smart objects impact playful and intergenerational interactions and collaborative exploration and creation of cultural content;

f) Envision a way to ensure the sustainability of the IoT system and to migrate the LOCUS intervention strategy and IoT system to other similar rural territories.

For pursuing the aforementioned objectives, the project is structured in the following 5 main phases (Fig. 1), which integrate several tasks that will unfold over 36 months (Fig 2).

A. Ethnographic & Bibliographic Immersion

In this phase, ethnographic research will be conducted (Fig. 2, Task 5), a methodology that has a specific focus on the culture of the group in which the ethnographer is immersed [38], using participant observation, interviews and focus groups to gather data.

By living in the village for 6 months, researchers will:

- Gain access to the inhabitants, stakeholders (such as local government entities, cultural and recreational associations, schools…) and visitors;
- Watch and listen to what people say and do;
- Engage people in conversations to know their life stories, motivations and wishes, understand what they find playful, how they establish playful interactions with others and with objects and probe other issues of interest.

It will also be possible to seek synergies with any current or future cultural or touristic initiatives, as it is considered crucial to engage stakeholders from the beginning, since they play a

strategic and structuring role in the sustainability of the IoT system in this territory, beyond the lifetime of the project.

This phase further comprises a Literature Review (Fig. 2, Task 4), aiming to characterize the state of the art and knowledge in the disciplinary fields the project aggregates.

B. Reflection and Preparation

This phase will allow the analysis of the data collected, as well as the interpretation, discussion and consolidation of all the information gathered and all knowledge acquired (Fig. 2, Task 6).

Creative sessions will be promoted, involving inhabitants, stakeholders and visitors, to brainstorm IoT playful intergenerational experiences in Amiais Village, which will then be designed, prototyped and evaluated in the following phase.

Still during this phase of the project, the technical requirements of the IoT system (infrastructure, wearable device and smartphone App) will be identified and prototyped.

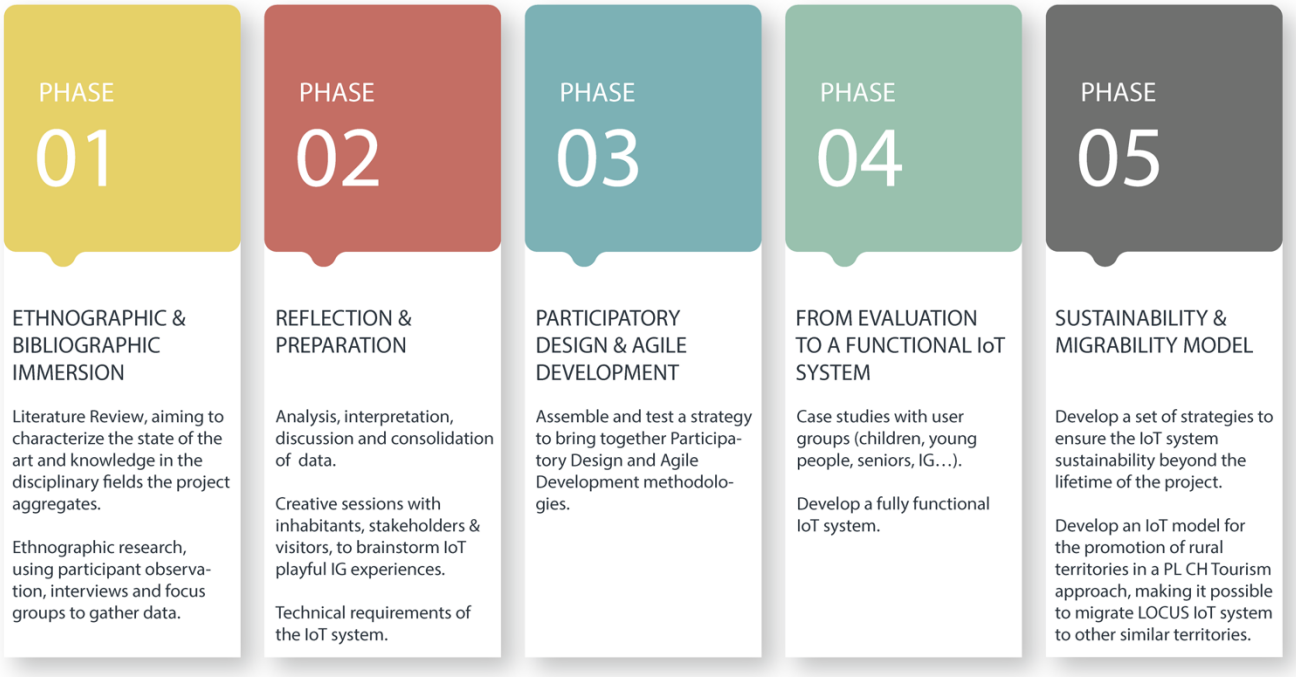

Figure 1. LOCUS' development phase

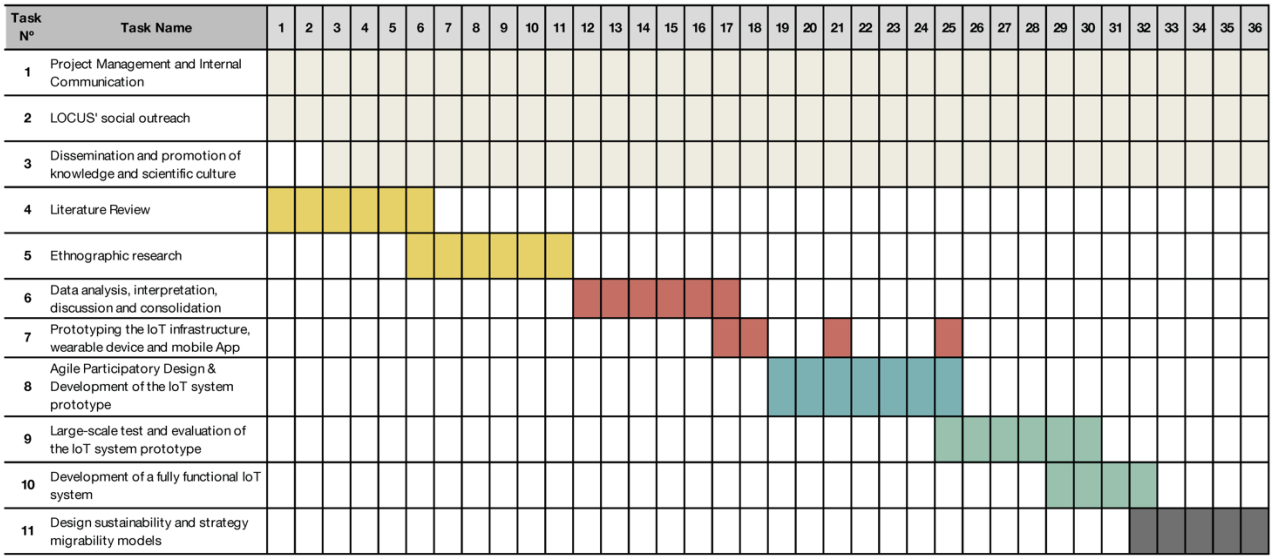

Figure 2. LOCUS' tasks and timeline

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C. Participatory Design & Agile Development

This phase will bring together Participatory Design and Agile Development methodologies (Fig. 2, Task 8). Participatory Design is about the direct involvement of people in the co-design of ICT they use and how design processes can be adjusted to embrace that involvement, namely by using design-by-doing techniques, such as mock-ups [39].

Agile is an iterative time-boxed methodology, involving design, development and testing sprints or iterations, which imply a continuous incremental improvement of what is being developed, greatly reducing costs and time to market [40,41].

As no satisfactory way to integrate these methodologies has yet been established (if one exists), the different strategies already used [40,42] will be analyzed and, by considering LOCUS specificities, a strategy of our own will be assembled and tested.

D. From Evaluation to a fully functional IoT System

Once a stable and robust version of the prototype has been developed, a large-scale evaluation of the IoT system will begin, through case studies with different user groups (children, young people, seniors, intergenerational…) (Fig. 2, Task 9).

Data will be collected through participant observation and individual interviews and the prototype logs will also be analyzed. This phase will be crucial to the pursuit of specific objectives d), e) and f), providing data to support Phase 5 (Fig. 1) and to develop a fully functional IoT system (Fig. 2, Task 10).

E. Design of a sustainability and a migrability model

Based on the results of the previous phases, it will be possible to develop a set of strategies to ensure the IoT system sustainability beyond the lifetime of the project and an IoT model for the promotion of rural territories in a playful and immersive cultural heritage tourism approach, making it possible to migrate the LOCUS' intervention strategy and IoT system to other similar rural territories (Fig. 2, Task 11).

Transversely to the aforementioned phases, an action plan for internal communication and for the dissemination and promotion of the project and its results in society and among peers and stakeholders will be designed and carried out (Fig. 2, Task 1, 2 and 3).

IV. Results & Outcomes

An IoT testbed will be installed in Amiais village. Over this testbed, playful and immersive gamified experiences (that will result from the co-design creative sessions to be undertaken in Task 6 (Fig. 2)) will be implemented.

People will be able to interact with tagged everyday things and points of interest around the village (such as farm implements, musical instruments, ox carts, buildings, trees, and so on), through the use of a wearable device (bracelet), their smartphones and an App.

These devices will identify the objects and how they are handled (by recognizing accelerations, movements and rotations of the wearer's hand) and the system will respond accordingly, by playing specific sounds, showing georeferenced information (through video, augmented reality, etc.), requesting the upload or sharing of specific multimedia content (videos, sound or photos), the search for a new object, etc.

For example, the husking of corn traditions and rituals can be one of the scenarios/narratives for an IoT immersive gamified experience. Listening, learning about and producing traditional music, such as the music linked to the *desfolhada* or *janeiras* rituals, through technologically augmented instruments, is another IoT experience that can be foreseen (since the specific scenarios/narratives will be derived from the co-design processes to be implemented).

Besides the IoT system and platform, the following are identified as the most relevant project outcomes:

- Innovative processes involving methods and tools for engaging inhabitants, stakeholders and visitors in the Agile Participatory Design, Development and Evaluation of an IoT system, which will be translated into a set of guidelines;
- A model to ensure the sustainability of the IoT system beyond the lifetime of the project; and
- A model to guide the migration of LOCUS' methodologies and IoT system to other similar rural territories (Amiais assumes itself as a prototypical village).

Further, the Participatory Design approaches to be implemented will allow the qualification of the local actors involved, creating context for the acquisition of new knowledge and skills, namely of an info-communicational nature.

This is a socio-intellectual capital of high value, that impact socioeconomic activities and future valorisation of the rural territories, being considered an important outcome.

V. Conclusions

LOCUS aims to understand how playful interactions with smart and social everyday things can be designed in order to create opportunities for Amiais's people to share their life stories and knowledge and for visitors to have an augmented experience of Amiais' culture and rituals, being able to collaboratively learn and produce and share multimedia georeferenced contents.

The project will assemble and test a strategy to integrate Participatory Design and Agile Development methodologies, through which inhabitants, stakeholders and visitors will be engaged in the co-design, development and evaluation of an IoT System.

Large-scale case studies with different user groups will provide testbeds for a real-world evaluation of the IoT system with real users.

LOCUS also aims to develop a set of strategies to ensure the IoT system sustainability beyond the lifetime of the project and an IoT model for the promotion of rural territories in a playful and immersive cultural heritage tourism approach, making it possible to migrate the LOCUS' intervention strategy and IoT system to other similar rural territories.

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